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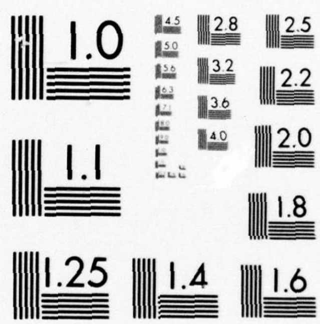

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) A MANAGERIAL APPROACH TO THE DETERMINATION AND SELECTION OF THE TACTICAL COMBAT SYSTEM FOR SURFACE NAVY SHIPS.		5. TYPE OF REPORT & PERIOD COVERED (9) Student Project Report, ~~74-1~~
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) JERRY E. WACKER		8. CONTRACT OR GRANT NUMBER(s) (11) May 74
9. PERFORMING ORGANIZATION NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT ~~COLLEGE~~ School FT. BELVOIR, VA 22060		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (12) 59p.
11. CONTROLLING OFFICE NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060		12. REPORT DATE 1974-1
		13. NUMBER OF PAGES 57
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

UNLIMITED

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DDC
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE: A MANAGERIAL APPROACH TO THE DETERMINATION AND SELECTION OF THE TACTICAL COMBAT SYSTEM FOR SURFACE NAVY SHIPS

STUDY GOALS: To outline a management approach which could lead to the development of a methodology (analytical tool) for the determination and acquisition of the optimum combat system for surface Navy ships.

STUDY REPORT ABSTRACT

This study report outlines a new management approach for developing a methodology for the determination of and subsequent acquisition of the optimum combat system for US Navy surface ships. The study examines the current practices and procedures used in tactical combat system selection and notes the weaknesses and deficiencies.

The study report also discusses the weaknesses in the current Navy organization as it relates to the acquisition of combat systems and proposes a reorganization which will facilitate the determination and acquisition of the optimum combat systems for Navy surface ships.

KEY WORDS: MATERIEL ACQUISITION SHIPS COMBAT ITEMS REQUIREMENTS MANAGEMENT ORGANIZATION ANALYSIS REORGANIZATION MANAGEMENT CONCEPTS PROJECT MANAGEMENT

NAME, RANK, SERVICE	CLASS	DATE
Jerry E. Wacker, GS-14, DNC	PMC 74-1	May 1974

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DEFENSE SYSTEMS MANAGEMENT SCHOOL

PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

A MANAGERIAL APPROACH TO THE DETERMINATION
AND SELECTION OF THE TACTICAL COMBAT SYSTEM
FOR SURFACE NAVY SHIPS

STUDY REPORT
PMC 74-1

Jerry E. Wacker
GS-14 DNC

FORT BELVOIR, VIRGINIA 22060

A MANAGERIAL APPROACH TO THE DETERMINATION AND SELECTION OF THE TACTICAL COMBAT SYSTEM FOR SURFACE NAVY SHIPS

An Executive Summary
of a
Study Report
by

Jerry E. Wacker
GS-14 DNC

May 1974

Defense Systems Management School
Program Management Course
Class 74-1
Fort Belvoir, Virginia 22060

EXECUTIVE SUMMARY

This study report presents a new management approach for developing a methodology for the determination and subsequent acquisition of the optimum combat system for US Navy surface ships.

The Navy establishment as a whole is relatively ineffective and inefficient in its selection of combat systems for surface ships, and the operating Fleet has relatively less capability, survivability, and operational readiness than desired, considering the cost and resources involved. We have no standard organization or procedures for the establishment of, and subsequent acquisition of, optimum combat systems. The commencement of the effort is always attended by interminable delays while we vacillate and argue about who is to do what. Since we have never done it successfully, we don't know what the finished product should be like; thus, we don't know what the priorities are and we don't know when we are through.

The acquisition program managers function as master planners and integrators. In recent years, primary design decisions are made by OPNAV. These are based on intuitive or empirical criteria; not on functional analyses. Fundamental design concepts, operational characteristics, initial equipment lists, etc., are developed by OPNAV, using basically a "bottoms-up" approach. This permits independent development of different elements of a combat system, thus leading to interface and compatibility problems. In addition, the combat system functions are specified in terms of specific equipments, rather than operational requirements.

The management approach proposed is a formal "systems analysis" planning model (tool) for progressing from mission objectives to achievement

of these objectives in an orderly and controlled manner, while ensuring that all parts in the total system are integrated and functional.

The study report also discusses the weaknesses in the current Navy organization as it relates to the acquisition of combat systems and proposes a reorganization which will facilitate the determination of acquisition of the optimum combat systems for Navy surface ships.

A MANAGERIAL APPROACH TO THE DETERMINATION AND SELECTION OF THE TACTICAL COMBAT SYSTEM FOR SURFACE NAVY SHIPS

STUDY REPORT

Presented to the Faculty

of the

Defense Systems Management School

in Partial Fulfillment of the

Program Management Course

Class 74-1

by

Jerry E. Wacker
GS-14 DNC

May 1974

ACKNOWLEDGEMENTS

I wish to convey my sincere appreciation to Captain C. Phillips, Mr. P. Prikals, and Mr. D. Perrill, all formerly my associates in NAVMAT PM-7T, who have contributed many hours of discussion on my study topic over the past two-and-one-half years, and who have greatly influenced my thinking and views on this research study; and Mrs. Pat Wacker, who helped with the data and provided outstanding secretarial support with the draft versions.

Contents

A MANAGERIAL APPROACH TO THE DETERMINATION AND SELECTION OF THE TACTICAL COMBAT SYSTEM FOR SURFACE NAVY SHIPS

SECTION 1

INTRODUCTION

1.1. Purpose

The purpose of this study is to outline a management approach which, if implemented, could lead to the development of a methodology for the determination and subsequent acquisition of the optimum mix of detection, destruction, deception, communications, command and control subsystems (i.e., combat system) for US Navy surface ships. It would be presumptuous to state that the approach outlined in this study will solve the Navy's problem of determination and selection of the optimum combat system for surface ships; however, this study will attempt to outline an improved method by addressing and seeking answers to the following two research questions:

Research Question 1: "Is the US Navy's current method of determining and selecting the combat systems for surface ships adequate?"

Research Question 2: "Is there a better way to determine and select the combat system for US Navy surface ships?"

1.2. Scope

This study addresses the US Navy surface ship's tactical combat system, which is the combination of equipments and subsystems, exclusive of hull; propulsion, navigation, and auxiliary machinery systems that provide the capability for the ship to carry out its primary and contingent missions.

The constraints of time and man-hours limited the scope of this study to only a couple of classes of surface ships and prevented the collection of

the multitude of numerical characteristics of the various subsystems for detailed quantitative comparison and analysis. However, this study does identify the first level of characteristics which are required and presents a systems analysis approach leading to the "determine and select" decision.

1.3. Conduct of Study

This study was conducted between February and May, 1974, concurrent with my attendance at the DOD Defense Systems Management School (DSMS), and involved research in the Naval Material Command and in the DSMS Library, as well as information obtained from unstructured student and faculty interviews, guest lecturers, and course notes during this period. I have also drawn on the valuable experience gained during my two-year assignment in a Project Management Office within the Naval Material Command.

1.4. Abbreviations and Explanations of Terms

For purposes of this study, abbreviations and terms are explained in Appendices 1 and 2, respectively.

1.5. Organization of the Report.

This study report is divided into six sections. Section 1, introduction, states the constraints and general method used. Section 2, related research, data collection and analysis procedure, discusses the outcome of the literature search and notes relevances and differences. Section 3, current method of tactical combat system selection, addresses the adequacy of the Navy's current method. Section 4, alternative method of tactical combat systems selection, outlines an improved method. Section 5, other findings, discusses organizational problems within the Navy.

Section 6, conclusions, recommendations and summary, summarizes the conclusions of sections 3 and 4 and presents my follow-on recommendations.

SECTION 2

RELATED RESEARCH, DATA COLLECTION, AND ANALYSIS PROCEDURE

2.1. Relevant Related Efforts

The greater part of the research and data collected for this study was obtained through contacts in the Naval Material Command (where I served in a Project Management Office for two years prior to attending DSMS); reference material I've accumulated during the past two years; and information I've obtained here at DSMS through dicussions with students and faculty, guest lecturers, and course notes.

My analysis consisted of comparing data on actual practices and procedures used in tactical combat system selection with conceptual models (both mine and others obtained from data collection).

In the course of researching my subject, I discovered that there were numerous related efforts (past and present). Some of these addressed one aspect of the problem while others addressed several aspects; these, therefore, are considered relevant. However, none seems to address all aspects that I cover in my approach.

2.2. Differences

As stated above, the material I located during my research appeared to address only various aspects, mostly in the areas of design, of the total combat system determination and acquisition process. The approach I have taken in this study addresses much more than design. It is "management" to produce the total system. It is the formal "systems analysis"

planning model (tool) for progressing from mission objectives to achievement of these objectives in an orderly and controlled manner while ensuring that all parts in the total system are integrated and functional.

SECTION 3

CURRENT METHOD OF TACTICAL COMBAT SYSTEM SELECTION

RESEARCH QUESTION 1: "Is our current method adequate?"

3.1. Discussion

This sections gives a brief overview of selected ship development and acquisition programs. A large portion of the material presented in this section has been obtained through unstructured, nonattributable discussions with various Navy personnel over the past two-and-one-half years and from nonattributable lecture notes of guest speakers here at DSMS.

The operating Fleet has relatively less capability, survivability and operational readiness than desired, considering the resources involved. Ship design occurs significantly as a "bottom-up" phenomenon and we tend to get the ship for better or worse as it may turn out, instead of occurring as a "top down" phenomenon where we would tend to get the desired ship with all the benefits of system integration. Design of our ships is accomplished by hull, space, and weight parameters first; then, after the general hull configuration is established, equipment lists and specifications of combat system functions in terms of specific equipment capabilities, rather than operational requirements, are considered. Thereafter, independent development of the different subsystems is directed. Integration then becomes an after-the-fact shoe-horn approach to place the subsystems on the host platform. We therefore have subsystems with adverse interactions.

Some of the problem areas in our current combat system determination and selection are:

a. Decision authority among the overall ship acquisition manager, the subsystem managers, and the special program managers is not clearly defined.

b. Overlapping responsibility leads to conflict of interest between subsystem managers and special program managers in regard to subsystem selection, system integration, and design characteristics.

c. Some contractor-furnished equipment can be utilized by the prime contractor on an "as is" basis without having to conform to specified technical requirements.

d. Prescribed standards are frequently in conflict with good system integration.

e. The R&D process is applied more to the new equipment role than to the system's capability and integration role.

These problems lead to ship's having the following general faults:

a. Systems not physically or functionally integrated. Functional incompatibility and/or physical mutual interference result.

b. Desired system or function not attained due to delayed decision resolution by management or due to lengthy decision appeal.

c. Hoped-for (and planned-on) advanced concept system not attainable. The ship then has a missing system or replaces that missing system with a less desirable but available system. The loss of the planned-for system may impact on other systems or functions, if interrelated.

d. Requirements change during formulation or construction, causing engineering changes which impact adversely on schedule, cost, documentation, and perhaps on integration or compatibility.

e. Specifications may not be met because of mismatched interface degradation, because of the substitution of equipment which was required or because of the contractor-furnished equipment used.

f. Some technical or physical areas are neglected because the responsibility is undefined, or because it is multiple and nobody wants it.

g. Unnecessary redundancy in terms of power supplies and antennae through lack of system integration.

h. General weakness in Command and Control area through lack of system integration or the inability to integrate.

i. Reliability and maintainability not known or determined in advance for many systems which then impacts on personnel and supply support capabilities.

j. Shipboard environment exceeding limits allowable for sophisticated equipment in terms of the combined effects of temperature, vibration, collocated equipment radiation, power input purity or stability, separation of interconnected units, calibration, emitter/receiver placement, external mutual interference, protection from salt water/moisture/exhaust gases, and so forth.

k. Operating ships, having been continuously modified, backfitted, and modernized, are at maximum allowable conditions of weight and moment. No other improvement or modification can be accomplished without an exchange of already-installed equipment for new equipment on an equivalent weight and moment basis.

This situation produces ships which, after acquisition and introduction into the Fleet, require on-board problem resolution and system-fix to improve performance, to improve reliability, to improve maintainability,

to reduce mutual interference generation and vulnerability, to relocate operator control positions or information display positions, and so on. This brings us back full circle to where the existing situation is undesirable, expedited short-term action is taken, funds manipulation is required, and the solutions accomplished generate impact in other areas or on the future.

Since the "concept formulation" procedure was established by OSD in about 1965, the Navy has made quite a few efforts to carry it off. No two tries were even remotely similar, except in two particulars: (a) all involved interminable delays and extensive waste of time (because no one knew what to do); and (b) all were spectacularly unsuccessful. To cite a few: (1:1)

a. The LFS (landing force support ship) remained in concept formulation in OP-36, CNA (SEG), and elsewhere, from the day concept formulation was first established until quite recently, with no noticeable results.

b. The MCS (mine countermeasures support ship) went through several phases in various locations, terminating in a year-long disastrous effort in NAVSHIPS (NAVSEC) that still stands as a "how-not-to-do-it" monument over the MCS gravesite.

c. The LAH (amphibious assault ship) sprang almost full-blown from CNA's NAVWAG-44, with no real Navy staff work, simply because SECDEF said "go." Actually, the CNA study started out to address quite a different problem.

d. In the flagship line, we worked on the AGC (amphibious flagship--now LCC) and the Fleet Flagship simultaneously, yet kept them so far apart

(with the AGC work being done at CNA (OEG) and the Fleet Flagship effort in OP-344) that these two Siamese twins didn't even know they were related--and each effort was a total failure.

e. In the case of the DXGN/DXG/DX (DD-963), we ganged up on the problem in every conceivable way. First, we did a "requirements" effort centered in OP-96, but with major inputs from every other OPNAV office, CNA, the Systems Commands, and even OSD (System Analysis). After a year or so of that, the OP-03D/MAT-09X organization spent another year--again with quite a spectacular team--essentially redoing the requirements study. (The two efforts produced remarkably different ships.) Then, just to be sure we had touched all bases, we turned the whole thing over to three complete teams in industry for some nine months and let them have a whack at it in competitive "contract definition" (funded at about $10M each). Finally, we jumped back into the Project Office for many months of evaluation and source selection--with liberal overtones of concept formulation all along the way.

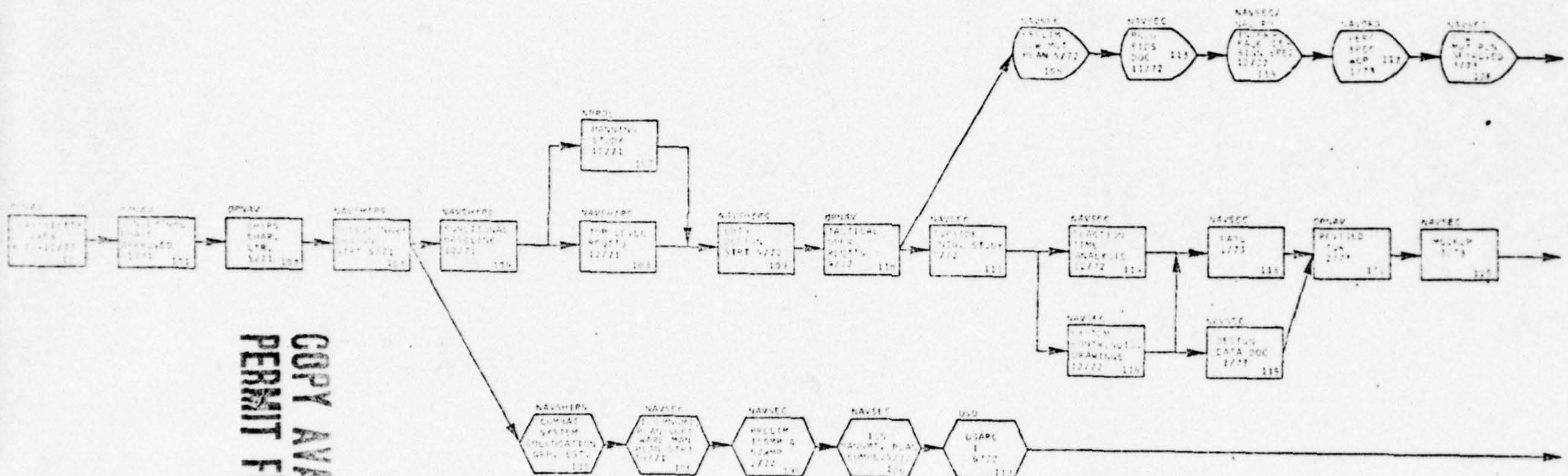
f. Moving to more recent times, in the case of SCS (sea control ship--formerly ACS (air capable ship)), we still seemed baffled as to how to go about it. The SCS concept was spotlighted by the CNO for rapid action in about August, 1970. We didn't get the "ACS Requirements Study" going until about December. The Study reported out in March, 1971, and got CNO decisions for proceeding with dispatch. We backed and filled for some four months, at which time the job of characteristics determination/justification was turned over to OP-96 (one of whose first tasks was to turn off a competing effort in NAVMAT (PM-15)).

g. In the case of the PF (patrol frigate), we got impatient and OP-36 and the CEB did a limited jury-rig job in a couple of months.

In attempting to discern the most significant influences and decisions affecting the patterns of acquisition on the resultant combat systems, it became evident that many of these originated at CNO or Ship Characteristics Board levels. The greatest impacts were created by innovations; i.e., introductions of new systems which had major, unforeseen impacts on performance, schedule, cost or size of ships acquisition programs. Stretchout, postponement or cancellation of these subsystem programs often led to major redesign of the total ship with commensurate cost increases and schedule delays. Examples of these on the DLGN-38 are the initial proposals to include AEGIS and SHORTSTOP and the subsequent iterations to remove these from the final ship design.

The next most influential technique affecting acquisition was the use of collocation or design working groups as forums for technical interchange of design data and a means of providing SHAPM's with the necessary inputs for technically and administratively appropriate managerial decisions.

The flow chart, Figure 3-1, shows the Patrol Frigate significant events. During the Concept Formulation Phase of the PF, various studies were accomplished for alternative subsystem trade-offs; radar, sonar, display consoles, gun, missile, and launcher systems. The majority of the subsystems were selected before the Preliminary Allocated Base Line (PABL), with the exception of the sonar system. It was selected after PABL with no change in the original size of the sonar equipment or sonar control area.



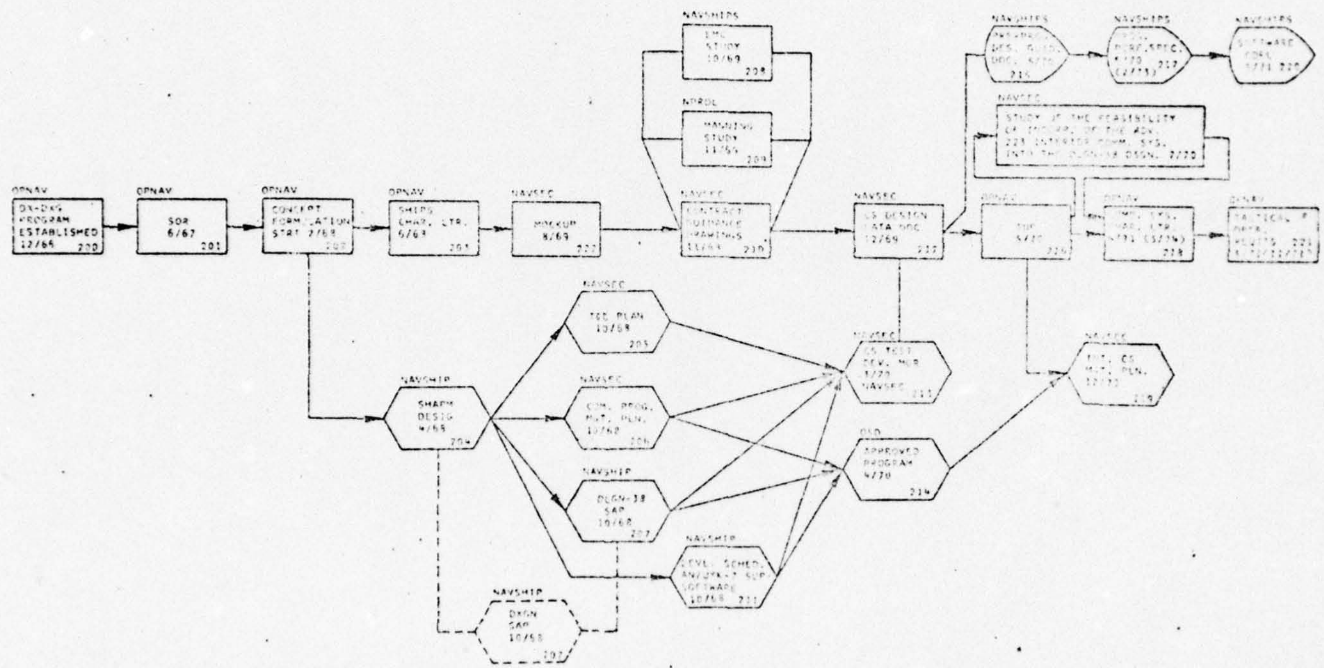
Source:, p I-10, Survey of Selected Ship Development and Acquisition Programs-Final Report [2]

Figure 3-1 Patrol Frigate Significant Event History

One of the major controversies that came up prior to and during PABL was the location of the MK-92 MOD 2 FCS antennae. The PF was the first ship the MK-92 MOD 2 FCS system was designed for, and there was very little information on its performance. The final selection of the antenna locations was made without a complete EMC (electromagnetic compatibility) study.

The flow chart, Figure 3-2, shows the DLGN-38 significant events. Perusal of the flow chart seems to indicate that the Tactical Operational Requirements (TOR) and Technical Development Plan (TDP) were issued after development of the Integrated Combat System Design Data Document (DDD). This appears to be out of sequence, but may have been caused by other events, such as the TOR being a relatively new document requirement needing clarification and specification, or changes in equipment and operational concepts requiring considerable modification and updating of existing documentation. Thus, the issuance of a Combat System Characteristic Letter, which should precede the TOR and the DDD, appears toward the end of the flow charts because this document requirement was innovated late in the DLGN-38 program. However, a late issuance of the integrated Combat System Management Plan cannot be justified by the above criteria. It was evidently published at about the time contracts were being let. The usefulness of Management Plans in general can be questioned if they are not a course of discipline in the acquisition program.

The original design of the DLGN-38 had, as a principal objective, ease of modernization when the Advanced Surface Missile System (ASMS), now known as AEGIS, was ready for installation. This required considerably more effort than a conventional design. The ship was first designed for



Source; p I-13. Survey of Selected Ship Development and Acquisition Programs-Final Report [2]

Figure 3-2 DLGN-38 Significant Event History

the ASMS and then the final design was derived by substituting the Tartar "D" MFCS and the AN/SPS-48 radar for the ASMS.

There were seven major alternate proposals for the integration of the combat system on the DLGN-38. The various proposals were alternate sonar systems, three search radar systems, IFF systems, navigation systems and centralized automatic test systems. The alternate systems were analyzed during the early stages of Contract Definition (CD) for impact on the total ship configuration and cost.

Those systems that were considered the most effective were integrated into the ship's combat system during the remainder of the CD period. A significant design problem arose during Contract Definition, when it was disclosed that the UHF communications transceivers would not be available in time for their incorporation into the design. The fall-back transceivers required considerably more space, which imposed a serious arrangement problem. The communications center had to be enlarged, which created a domino effect on the surrounding spaces. The final arrangement required major changes in the original design due to the change in the one subsystem.

Another major system that created problems was the Electronic Warfare System (EW), designated "Shortstop." Space and weight were originally reserved for Shortstop on the DLGN-38 due to production not being able to meet the ship schedule, but subsequent events on the Shortstop Program have made it necessary to resort to another EW system. (2:1-6)

3.2. Conclusions

It is very difficult to particularize about the causes of non-standard approaches or even to indicate that deviations from a given

pattern of approach (logical or otherwise) are necessarily bad. Initial perusal of the data and review of ship's acquisition programs of interest would indicate that the level of documentation required is taking a quantum jump. By virtue of the additional documentation and the accompanying controls in the process of being established, it appears that there should be much clarification of design detail (and additional cost and schedule risks). This is especially true of areas pertinent to combat systems' operational characteristics and associated software. Changes have already taken place in the CF/CD stage in terms of expanded, clarifying documentation. However, in the combat system development phase, only two major documents carry the burden: the Integrated Combat System Management Plan and the Design Data Document. The concern is with the comprehensive information required to be included in these documents. The contents could be clearly described in such a manner as to not permit dilution of technical or managerial information. The technical content of the Design Data Document should track all critical design changes.

Design problems are inherent in modern combatant type ships due to the complexity and amount of electronic and mechanical equipment that has to be integrated into a viable combat system. Regardless of the expertise of the management and technical design team, design problems are generally in direct proportion to the amount of new equipment and innovations brought forth in a new combat system. The design is further complicated by the fact that many government agencies and private contractors participate in the design with numerous problems.

A general observation can be made that planners rarely leave space for future expansion. Thus, when subsystems are added or modified, major reconstruction of spaces is often required.

The following represents some generalized commentary which evolved from the data reconstruction survey on the PF and DLGN-38. (2:1-40)

Management:

-- Poor traceability of events.

No overall histories (or detailed plans) available from inception of program through first several years of life cycle).

-- Sequence of events not consistent.

Activities often occur late and out of sequence.

-- No feedback evident.

a. Where were decisions made?

b. Did changes in system occur?

c. What caused them to occur?

d. Did studies have any effects?

(1) Results rarely documented;

(2) Impact not indicated.

e. How are deficiencies corrected?

-- Documentation interdependencies not clearly indicated.

-- Schedules do not make allowances for delays, corrective actions, etc. Instead of planning in advance and adhering to schedules, the schedule is revised (either extended or by-passing an original requirement).

-- Communication between Operating Forces and Technical Community needs improvement.

The Design Problem

-- Fundamental design concepts, operational characteristics, initial equipment lists, etc., are developed by OPNAV using a basically "bottoms-up" approach. This permits independent development of different elements of a combat system. The design problem (except in CIC) is interface and compatibility solutions, rather than true integration. Thus, too, the combat system functions are specified in terms of specific equipments, rather than operational requirements.

-- Naval System Commands develop equipment to generalized criteria, rather than specific operational need to spread costs of development, production, and logistics over many ships.

-- The activities of NAVSEC are to a great extent limited to interface and compatibility solutions (sometimes called system integration), design detail, and problems related to physical emplacement and employment of shipborne equipment. Some of these relate to size, space, maintenance access, weight, power, illumination, operational spaces, habitability, machinery, structures, equipment compatibility, etc.

-- The Acquisition Program Managers function as master planners and integrators. In recent years, primary design decisions are made by OPNAV. It should be noted that these are based, in many cases, on intuitive or empirical criteria; not on functional analyses.

-- The Design Problem can be summarized by a simplistic statement: "Design decisions at OPNAV; detail implementation at NAVSEC

levels; in between, integration and coordination activities."

In the review of what goes wrong in design cycles, we come across frequent breakdowns in communication, both as to message content and timeliness due to the large number of coordination interfaces and frequent iterations of each design decision.

SECTION 4

ALTERNATIVE METHOD OF TACTICAL COMBAT SYSTEM SELECTION

RESEARCH QUESTION 2: "Is there a better way?"

4.1. Discussion

In the previous section we looked at some of the key aspects of the Navy's current method of selecting combat systems for its surface ships. In this section we shall focus on a management approach which, if implemented, could lead to the development of a methodology for the determination and subsequent acquisition of the optimum mix of detection, destruction, deception, communications, command and control subsystems (hereinafter referred to as the "combat system") for US Navy surface ships. As stated in Section 2, a great deal of related effort, past and present, has addressed some aspects of the problem, but most of these were directed only at the design process. Examples of these are: (1) the Coordinated Ships Electronics Design (CSED) (3 volumes); (2) Shipboard Integrated Electronic Suite (2 volumes); (3) NAVSEC DDG Design Process (8 volumes); (4) Guide for Concept Formulation, NAVSHIPS 0900-060-0100; (5) Guide for Contract Definition, NAVSHIPS 0900-054-9010, etc. There are many more excellent documents, but none appeared to address the "management overview" approach that I will outline in this report. Most specifically, my approach is developing a planning model (tool) for progressing from mission objectives to achievement of these objectives in an orderly and controlled manner, while ensuring that all parts in the total system are integrated and functional.

Early in the research phase, it became evident that many of the Navy's combat system selection problems are a result of an improper organization as brought out and discussed in the previous section. It is unlikely that I, or this study report, will be able to direct or influence the reorganization of the Navy, so the approach I have outlined in this section is based on the current Navy organization (but takes into account the soon-to-be-implemented NAVORD/NAVSHIPS merger). However, I feel very strongly about the need for reorganization to improve the combat system determination and acquisition and have therefore included my views on reorganization in the next section, titled "Other Findings." I choose to treat the reorganization problem spearately so as not to make the usefulness of this study totally dependent on reorganization.

The new methodology that I propose be developed would be used for:

a. New total ship design;

b. Evaluating changes to current ships;

c. Choosing off-the-shelf systems for new ships;

d. Showing up incompatibilities in current suites;

e. Predicting new subsystem needs;

f. Providing rapid reaction on probable performance versus cost prediction; and

g. Altering fixed concepts of ship design.

The complexity of new systems, of the functions they perform, of the ships themselves, and of the command/control intra-structure has grown in relation to size and scope, making it impossible to create an effective combat system without having considered the total ship as a system, and

applying systems analysis techniques to the total ship. At present, there is no known proven method considering the entire ship capability. (3:1) Current methods are not improving ship performance at a rate consistent with introduction of new technology. The new methodology must provide solutions to improve:

a. Crew survivability;

b. Subsystem development criteria;

c. Adverse interactions between systems/equipments;

d. Adverse competition for ship facilities/services;

e. Combat system requirements definition;

f. System reaction time;

g. Reduction in personnel; and

h. Operability of systems/equipments.

The proposed new methodology is divided into five phases (see Figure 4-1):

a. Mission and Functions;

b. Functional Parameters;

c. System Classification;

d. System Definition; and

e. System Location.

Missions and Functions--Phase I. In order to permit a logical development of the combat system, criteria must be established to define desirable top-side function and material distribution and to assist in resolving conflicts in choice of locations for various systems/subsystems and functional and physical areas and spaces. It seems clear that these criteria depend

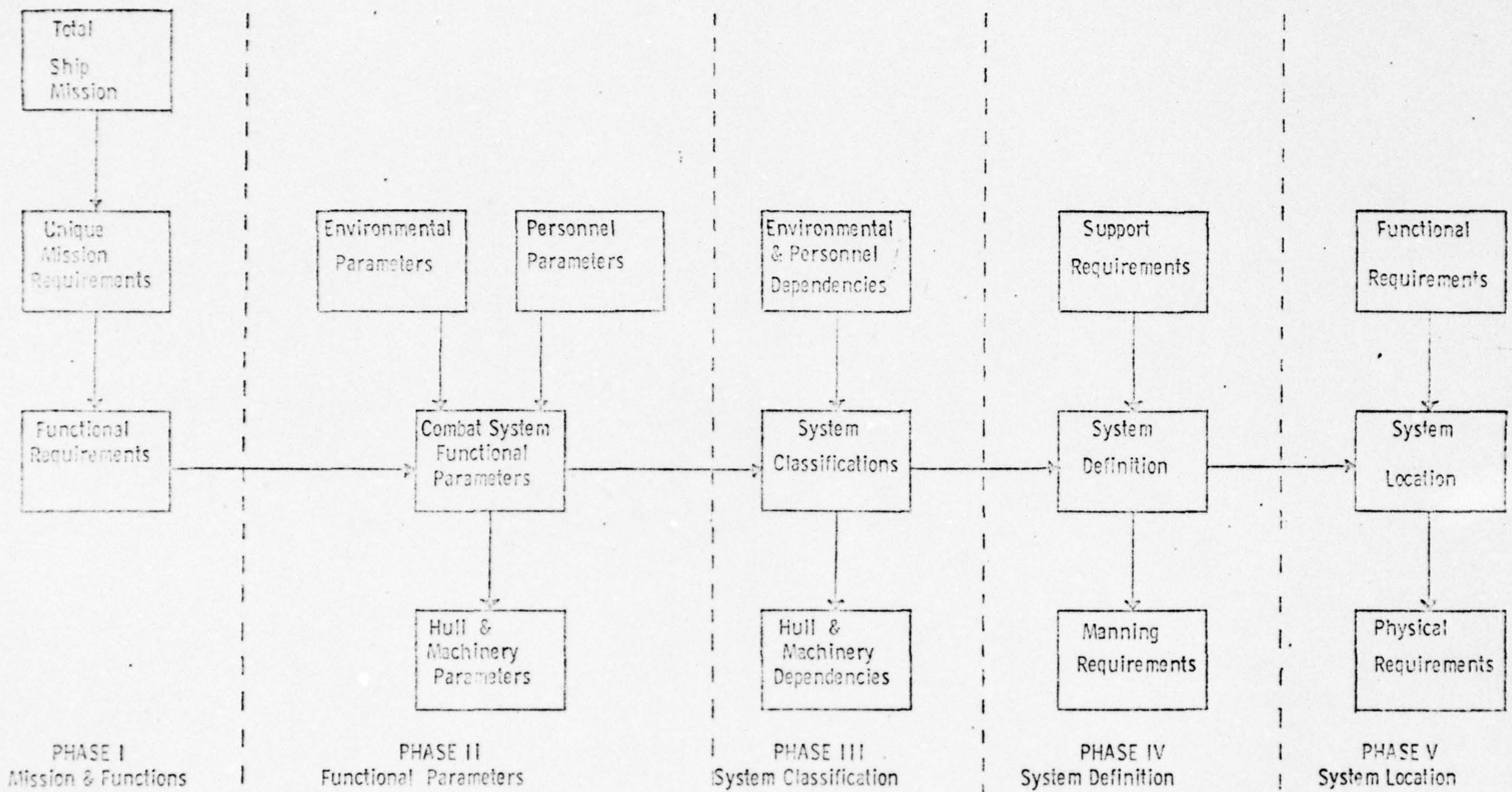
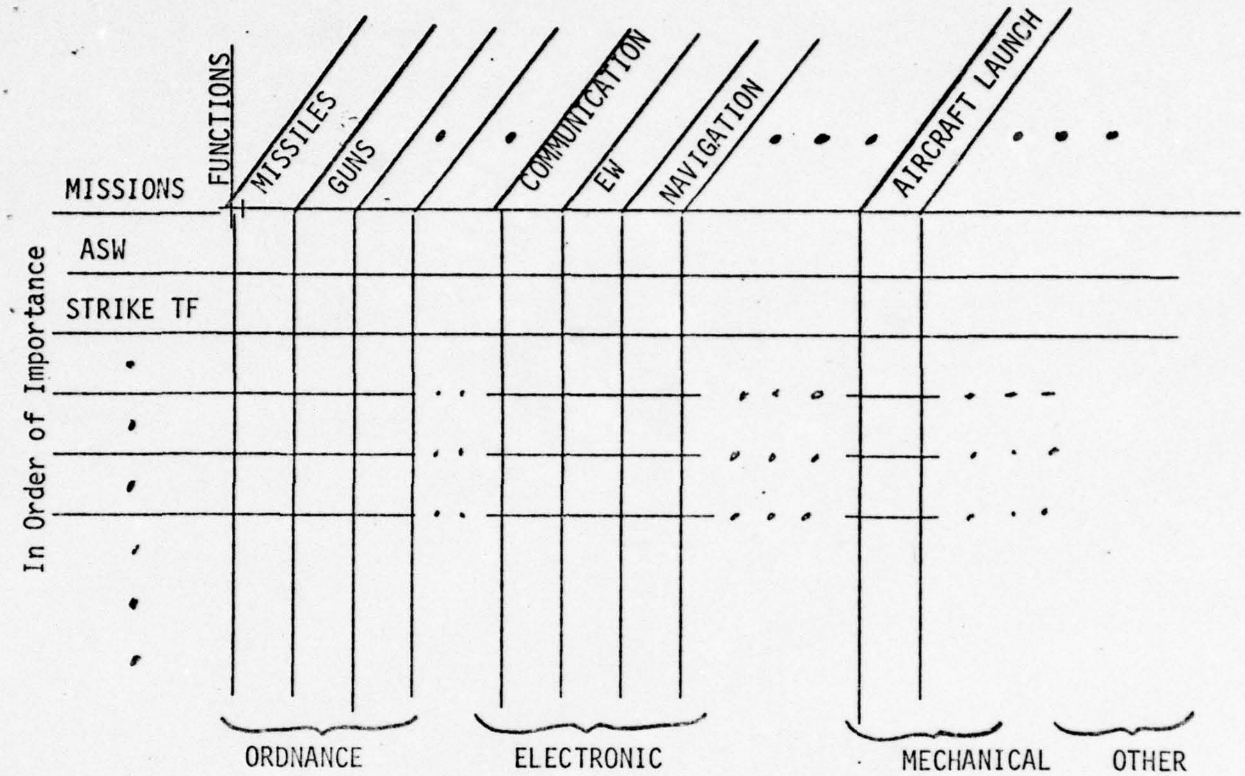


Figure 4-1 Combat System Development Phases/Functions

directly on the mission(s) which the ship will have to perform. It is envisioned that a given ship will actually be required to operate within a variety of missions. For each ship investigated, these must be carefully and explicitly defined. And, in addition, the relative importance of each mission must be established (perhaps through interviews or reviews of existing documents) as a data input to the program. When organized, then, these data will still have gaps to be filled on the basis of analysis or additional sponsor input. Collection and organization of data in this fashion can be a very tedious job.

If, however, a realistic organization and location scheme for the various systems which are required for the performance of such missions is to be made, such a relevant set of missions will have to be defined and priorities assigned (see Figure 4-2). The use of such a priority scheme on a mission basis will permit at least qualitative trade-offs to be made in the placement of equipment required to perform the chosen mission, and will constitute a major step in establishing locational precedence for the various systems.

Once the missions and their relative levels of importance or priorities are established, a listing of the functions which must be performed by the ship for each mission type will be required. The next step, therefore, is to determine the functions which must be performed to accomplish each mission. In many cases the functions which must be performed will be self-evident from the mission definition. However, the successful fulfillment of some missions may require a number of tactical and system interplays which enter into the success of the specific mission in a variety



PHASE I - Matrix entry indicates relative importance of function in performance of mission. Not all cells will be filled. Some functions may have equal importance.

Figure 4-2 Matrix Showing Relative Importance of Missions and Functions for Some Ship

of ways. The functions which must be performed to accomplish a given mission, along with the importance of the function in support of the mission, must be specified.

A given mission may require one or more electronic functions such as:

a. Communications;

b. Navigation;

c. Electronic Warfare;

d. Search, etc.

Likewise, the mission might require ordnance functions such as:

a. Missiles;

b. Torpedoes;

c. ASROC;

d. Guns;

or, mechanical functions such as:

a. Boat launching;

b. Helicopter support.

The importance of each of these functions to the overall success of the mission may not be the same. Communications, for example, may be desired in an anti-missile defense mission; however, the communications function may be secondary to the missile track and launch functions.

Or, for example, since the navigation function may be required for all missions, navigation may well be the highest priority function. If so, navigational requirements would take precedence over all other functions. The second priority function might be something like surface-to-air missile defense. If so, system components required for that function would take

locational precedence over system components required for shore bombardment or antisubmarine warfare, which ordinarily desire locations which conflict with the performance of the surface-to-air system function.

Functional Parameters--Phase II. The preceding phase discussed the definition of the missions and functions required for each mission. Second is a step which consists of a more detailed study of the functions. During this activity, all of the various parameters, in terms of which the functions may be characterized, must be tabulated.

In performance of a given mission, the various candidate systems for the ship will have to meet certain specifications to adequately perform the required functions. Also, since a given function may be required for several missions, the definition of the parameter required for performance for each of them could be used as the basis for an analysis to determine what consolidation, time-sharing, or space-sharing trade-offs are feasible.

An example serves best to illustrate the type of information required. For any mission which requires a radar search function, the radar system parameters must meet certain specifications to adequately perform the mission. These parameters might be, for example:

a. Size of target to be detected;

b. Minimum acceptable range for given detection probability;

c. Spatial resolution cell required; and

d. Area of coverage.

(A more complete listing of these parameters is shown in Figure 4-3.) Associated with each parameter is a numerical specification determined from the mission application.

FUNCTION: LONG RANGE SEARCH

PARAMETER \ MISSION	ASW	STRIKE TF			• • •
RANGE	NMs 50	NMs 120			
RANGE RATE	"	"			
AZIMUTH	"	"			
ELEVATION	"	"			
P_D CUMULATIVE					
P_D SINGLE SCAN					
G_R MINIMUM					
•					
•					
•					

PHASE II - Matrix Entry Indicates Specification for Parameter for Each Mission. Not All Cells Need Be Filled.

Figure 4-3 Example of Matrix Showing Dependence of Parameter Specification on Mission

Similarly, for a mission such as "abandon ship," some of the parameters which characterize the function are:

a. Total life boat capacity required;

b. Maximum time allowable for launch; and

c. Minimum space required for assembly of personnel.

The parametric specifications for a given function should be defined in terms of minimum acceptable properties, and on the basis of an operational analysis. Thus, while idealistically a communications coverage of 360 degrees in azimuth may be desirable, a coverage of 300 degrees might be tolerable and would allow considerably more flexibility in the placement of a radiating system.

It is clear, then, that the information developed in phases I and II provides a data base from which the combat system configuration criteria can be evolved. It is envisioned that this information would be utilized in at least two ways. The first would be for the purpose of developing a matrix which would interrelate the missions, the functions which must be performed, and the performance required (i.e., the parametric specifications). One output of such a matrix analysis would be an assessment of the relative importance of common functions and functional parameters. For example, it may be possible to compromise a particular functional specification, which must only be achieved for a single low-priority mission, in favor of a functional specification which is common to several missions and has a high priority in each. The second utilization of the above information would be as inputs for phases III and IV, which are discussed next.

System Classifications--Phase III. The output from the first two phases would provide information on the functional specifications required of various systems for performing the chosen set of missions. During phase III, the equipment classes necessary to perform the functions must be defined. The functional characteristics must be analyzed to determine what classes of system could be employed to satisfy the requirements for a maximum number of required functions. It is anticipated that in some instances, more than one class of equipment would satisfy the required characteristics. If this is the case, the choice of equipment class might be determined on the basis of minimizing the total number of equipments. Thus, for example, the requirement for detection over a specified range might equally well be satisfied by different frequency bands of radars or passive EW equipment. And the actual choice of equipments might be that which minimized total numbers of equipments over the whole mission set.

In some instances, the intermediate step of system definition indicated during this phase may be unncesssary. This will occur when only one system or class of system will satisfy the functional requirement.

System Definition--Phase IV. The efforts of the third activity should result in the definition of the class or classes of equipments or systems which will satisfy the overall requirements imposed by the mission sets. The next step, which is the purpose of phase IV, is to define special systems which fall into the above classes and satisfy the requirements. Analysis under this task should be directed toward minimizing the total number of individual systems or equipments, by time-sharing, those which

can be made to satisfy the functional characteristics required by the various missions. In addition, manning requirements should be considered to minimize system operational manning requirements. It has been estimated that manpower costs consume 55 percent of the life cycle costs of a ship, and that by 1975, these costs will be 65 percent of the Navy's budget. (4:ii)

The goal of this phase is to specify the systems only in sufficient detail to assure the satisfaction of the mission requirements, and to permit assessment of system parameters which must be considered in the combat system design. In some instances, this may take the form simply of relating them to a specific equipment such as an AN/XYZ receiver, while in other cases, it may be only necessary to stipulate a set of requirements which are within the state-of-the-art and will fulfill the mission demands. In this latter case, it may be necessary to estimate some of the factors which may have a bearing on the combat system design, such as, for example, size, weight, radiated average power, sensitivity, etc.

One of the important factors which is felt to be a necessary output from this phase is not only the specific system, but the number of such systems which is required for mission performance. For example, for H.F. communications, how many transmitters are required? . . . antennae? One per H.F. transmitter, or one per ship? . . . lifeboats--how many? . . . five-inch guns--how many? . . . surface-to-air missile launchers--how many? . . . etc.

It can be seen that the output of phase IV is the definition of specific systems required for the mission performance. Primary concerns

here are: "How does the mission relate to a specific system?" and "How does the specific system relate to the combat system design requirements?" Again, of significant importance is how many of each system type must be considered. It is one problem to determine the optimum location for a missile launcher; but the considerations involved in locating two might be considerably different.

System Location--Phase V. For the purpose of system location, the functional specifications of phase II for a given mission should be weighted in their overall impact on mission success. It is obvious that not all characteristics which a system possesses are equally important. Thus, for use as a "first cull" location iteration, the capabilities which are required in a gross sense for success of each mission should be spelled out. At this point, characteristics or requirements which do not obviously impact on the system location can be ignored.

In an earlier portion of this discussion, the utility of a matrix which could interrelate such factors as the missions, the functions which must be performed, and the characteristics was cited. Similar analysis should be performed to generate from the mission priorities a rank ordering of systems which could be used as a basis for making decisions and resolving conflicts in a location iteration. The rank ordering or assigning of priotities to the various systems is seen to be a necessary and crucial step in the development of an objective and logical combat system design.

The next step in the development of a topside location procedure is to mathematically define a coordinate space which can be used adequately to define the location of topside equipment and structures.

In general, approach to a location routine is best discussed initially in more-or-less outline form such that the steps are readily identifiable. There are several variations to the present approach which could be postulated; however, the development which follows is believed to contain the significant factors for a realizable approach. The steps are as follows:

a. Define a coordinate space which is minimally acceptable for each system in the absence of all other systems. It is not evident over what set of systems this first space cull should be made. Perhaps all systems should be considered, or perhaps only the systems with the highest priorities should be considered. In any case, an acceptable volume for at least the most important system will be generated.

b. Within the subspace which is acceptable for the highest priority system (the "A" system), determine that subspace which is a desirable location for the least number of other systems.

c. Assign the highest priority system position to the subspace defined in b, above.

d. With the highest priority system in its specified location, move the second priority system through its acceptable locations to determine a set of points for which a minimum conflict exists with:

   (1) the requirements of system "A";

   (2) the requirements of system "B."

e. Place system "B" in one of the locations determined in d, above.

f. In turn, determine subspaces for each successive system which minimizes conflicts with higher priority systems.

g. Impose second-order interactions requirements on each system and evaluate the impact of these interactions on the location choices resulting from the primary requirements.

h. Adjust locations to minimize second-order effects.

4.2. Conclusions

It has been the goal of this section of the study report to provide an outline of an approach to the general problem of combat system selection; an outline which could serve as a basis for discussion and refinement, and lead to a program embodying the precise objectives of the Navy in this important area. The outline aims at the most salient points along the way, only hinting at some of the side issues such as special operational analyses and the need for types of information which may be hard to obtain.

SECTION 5

OTHER FINDINGS

In Section 3, the conclusions stated that imporper organizational structures within the Navy were at fault for many of our combat system deficiencies. We have no standard organization for the establishment of combat systems selection and acquisition. In this section, I will discuss organizational weaknesses and propose a new Navy organizational structure which I feel would improve our method of combat system selection.

We have no standard procedure as to how it (combat system selection) is accomplished; thus, each new organization (e.g., SHAPM, PM, etc.) is left to its own devices to decide what to do, and the resulting poor progress leads to the great likelihood that the project will be reassigned to another office to do something (again, undefined) differently.

The non-standard approach leads to major personnel inefficiencies. Since we never do it the same way twice, our players are always unfamiliar with what they are doing, and we never develop a trained team of analysts. By shifting the lead around from office to office, we compound this. Since no one office is staffed for it or has the breadth of competence to handle it, we often form interoffice study groups, which virtually guarantees that the people detailed by each individual OPNAV and NAVMAT office will: (1) be new to the work; and (2) be those who can be spared, rather than those who are best at the job. (1:4)

Relatively short-duration (2 or 3 years) billet assignments increase the tendencies to seek short-term problem solutions and short-term problem implementations. Military and civil service personnel, alike, generally

feel that action and accomplishment are favorable to their career production. The Service member's feeling is further accentuated by a relatively short assignment. Thus, a high-activity, short-term effort is generally preferred to a well-planned, long-term effort. Career promotion motivation seems to center around such notions as: (1) long-range planning which is poor or has fallen into jeopardy because of a predecessor and will reflect poorly on the incumbent; (2) for good managers, problems are not problems--they are opportunities to excel; (3) good managers get things done while others are still planning; (4) solve your problems immediately, which gets the ball out of your court; and if that makes problems for other people, then they have to get the ball out of their court; and (5) promotional success is accelerated and assured to senior levels by recognizable individual accomplishment, rather than by team performance. The unfortunate result is that individual considerations tend to displace organizational or institutional considerations. Thus, methods which reduce time and increase activity, such as research and development having direct Fleet introduction, studies and analyses by industrial sponsors, interim fix solutions, and so on, are eagerly sought or accepted by managers at all levels.

The past approach has guaranteed inconsistent scenarios and strategies--a major obstacle to our developing (within the Navy) coherent thinking on future strategy, as well as being a major obstacle to approval of the work by reviewing authorities. Additionally, it simply requires many wasted man-months for each new group on a ship characteristics effort to start from zero in developing a view of the future Navy and our future strategy.

The same is true of threats, since threat analysis must be done anew each time by inexperienced people. We waste great amounts of time in execution, and wind up with duplicated efforts so inconsistent that they invite rejection by reviewing authorities.

Obviously, there are a great many different methods of organization possible. I tend to favor one somewhat patterned after the 1971 Rapp Report (5). (The Rapp Report is named after RADM Rapp, who chaired a joint SHIPS/ORD/ELEC committee tasked by the CNM to examine the problems of ship integration.) The current NAVORD/NAVSHIP merger was proposed in the Rapp Report, as were other alternatives.

From a most general overview, the OPNAV organization can be considered as producing policy, plans, programs and requirements; the NAVMAT organization, as producing equipment, systems, aircraft and ships; and the Fleet organization, as utilizing ships and aircraft at sea. It will be seen that in these organizations a duality of authority has been created organizationally, and also a duality of responsibility has been created organizationally.

In OPNAV, the duality is comprised of type warfare offices on the one hand, and warfare support offices on the other hand. Type warfare is embodied in the offices of Submarine Warfare, Surface Warfare, and Air Warfare. Warfare support is embodied in the offices of Manpower, Logistics, Plans and Policy, Program Planning, Fiscal Management, Systems Analysis, Command Support Programs, ASW TEMP Programs, RDT&E, and Education and Training. Thus, any policy, plan, program or requirement held sacred to a type warfare office is quite likely considered to be in the purview of several warfare support offices. Similarly, any policy, plan, program or requirement

held sacred to a warfare support office is quite likely in the purview of all three type warfare offices. As a result, there inherently exists a diversity of viewpoints concerning the aspects of almost any policy, plan, program or requirement. Authority can be vested in either half of the duality (or even both halves), and responsibility or impact may well occur in the other half.

In NAVMAT, the duality is comprised of System Commands on the one hand, and Program Managers on the other hand. System Commands include the offices of NAVAIR, NAVELEX, NAVFAC, NAVORD, NAVSHIPS (NAVSEC) and NAVSUP. Program Managers include the offices of the NAVMAT Program Managers, of which 8 or 9 currently exist (including POLARIS/POSEIDON, TRIDENT, ASW, Advanced SSN, Systems Integration, etc.), and some headquarters staff level programs. Thus, any equipment, system, aircraft or ship held sacred to a System Command is quite likely considered to be in the purview of several Program Managers. Similarly, any program sacred to a Program Manager quite likely has portions within the purview of several System Commands. As a result, there inherently exists a diversity of viewpoints concerning the aspects of almost any equipment, system, aircraft or ship. Authority can be vested in either half of the duality (or even both halves), and responsibility or impact may well occur in the other half.

The major advantage to be gained from this particular organizational rationale is that of attaining optimized efficiency and effectiveness. The optimization results from the probability that all aspects of every item (ships, aircraft, policy, plan, program, requirement, equipment,

system, Force, etc.) will be considered, and that a desirable balance of these aspects will result for every item by having to consider the parochial interests of the various commands and offices involved. Multiplicity of responsibility would (through an equilibrium of parochialism) create strength and economy, another well-intentioned rationale. But this rationale is based on the necessity that people be predominantly cooperative, constructive, team-oriented, and responsible in the professional sense of the word. This has not been the case, and is, of course, part of the problem.

There are most probably a variety of reasons why people have not been able or willing to work within the professional requirements of the organizational rationale. The competitive, aggressive desire to improve one's own organizational strength and to produce recognizable accomplishments as an individual is certainly a significant factor. Organizational strength is improved by staff expansion, by increasing one's scope and weight of authority, and by controlling more funds or material. As previously seen, career promotion aspects favor recognizable accomplishments by individuals, rather than superlative but obscure team or group accomplishments. The duality concept of authority existing within major Navy Department organizations is a situation which invites staff expansion, manipulation of authority, the separation of responsibility from authority, and manipulation of funds control within those organizations. The very relationships which serve to desirably maximize the organizational product produced by cooperative, constructive, team-oriented and responsible members also serve to undesirably minimize the organizational product produced by members whose objectives are staff expansion, increased authority, parochial dominance, funds control, and professional recognition as individuals.

Recent solutions have dealt with trying to control the <u>effects</u> of the problem, but have not attacked the <u>causes</u> of the problem. In many cases, an office or management staff has simply been established to deal with the effects of an undesirable problem. Since many problems are a result of organizational authority overlap in the first place, interposing yet another authority will do little toward resolving the issue of that problem.

The theoretical solution is not necessarily a practical solution or a desirable solution--but it is the fundamental solution which attacks the root cause of the problem, rather than the effects of the cause.

The theoretical solutions to this problem consist of three major thrusts: one at stabilizing the annual Navy budget appropriation; one at inherently motivating individuals to attain performance benefitting the entire establishment; and one at reorganizing major Navy commands to avoid the organizational duality that exists for both authority and responsibility. For purposes of this report, I have emphasized the latter.

OPNAV, NAVMAT, and the Fleet Command structure must be reorganized to attain complete continuity of authority and responsibility within unique, unambiguous chains of command.

I have devised the essence of such a reorganization for NAVMAT (see Figure 5-1). It will be discussed in the following paragraphs. The same rationale can be applied to the OPNAV and Fleet organizations as was applied to NAVMAT.

Within NAVMAT, such a reorganization could be accomplished by creating three levels of authority under the Chief of Naval Material (and the Vice

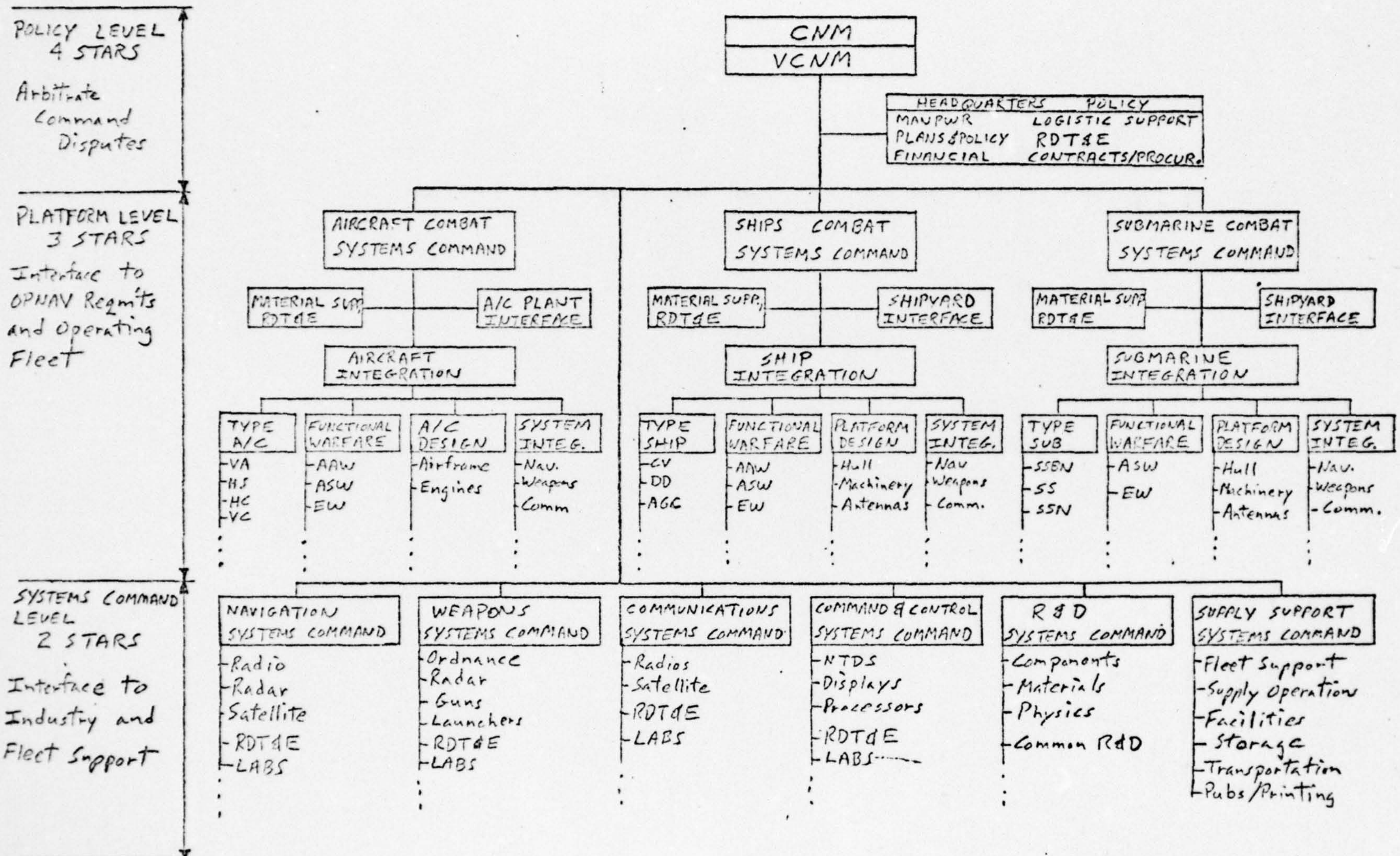


Figure 5-1 Proposed Naval Material Command Organization Structure

Chief of Naval Material)--the Headquarters Staff Policy level, the Combat Systems Command level, and the Systems Command technical level.

The Headquarters policy organization would be comprised of offices for Program and Financial Management; Manpower, Procurement and Production; Research and Development; and Logistic Support.

The Combat Systems Command organization would be comprised of the Ships Combat Systems Command, Submarine Combat Systems Command, and the Aircraft Combat Systems Command.

The three Combat Systems Commands would be organizationally and functionally identical. At the Commander's staff level, there would be an office for Combat Systems RDT&E, an office to interface with the shipyards/aircraft plants, and an office for special programs. Under the Commander would be the Vice Commander and four major divisions. This is where the essence of the reorganization would be accomplished.

The four divisions would be: (1) type ship (or type aircraft) division; (2) the warfare division; (3) the ship design (or aircraft design) division; and (4) the technical systems division. The purpose of the arrangement would be to produce, under the single decision authority of the Vice Commander's office, a ship or aircraft designed from the top down in fulfillment of OPNAV requirements, supporting all specified warfare functions, with Combat System integration and compatible to the utmost. The type ship (or type aircraft) division would serve as warfare systems design integrators whereby the proper mix and balance of AAW, ASW, EW, EMCON, and the offensive mission would be provided and integrated conceptually. The technical systems division would serve as systems equipment integrators

whereby the proper systems equipment would be provided and integrated from a physical standpoint. The ship design (aircraft design) division would serve as hull (airframe) and power plant design agency with respect to achieving the physical characteristics of speed, range, weight, etc., and as the design agency for incorporating the integrated equipment systems into the hull or airframe.

The four divisions would provide all of the aspects needed to design a fully integrated Combat System platform (ship or aircraft), and would do so under the decision authority and responsibility of a single office, the Vice Commander for Ship (Aircraft, Submarine) Combat Systems Command.

The equipment systems, being common to all three Combat Systems Commands, would be under the technical management and authority of the Systems Commands. This would provide interfacing between the Navy Technical Systems Commands and industry.

The Systems Command organization would be comprised of the Navigation Systems Command, the Weapon Systems Command, the Communication Systems Command, the Command and Control Systems Command, the Research and Development Command, and the Supply Support Command. The Systems Commands would maintain the technical expertise, the industrial interface, contracting, RDT&E with respect to their own systems, accomplish system interfacing and integration in conjunction with the Research and Development Command, have technical responsibility for quality assurance, value engineering, standardization requirements, and so on.

While this brief explanation has not considered all functions accomplished within NAVMAT, other functions would be incorporated into the

organization with respect to being at the proper organizational level, and within that level as required by chain of command authority considerations.

It appears that reorganizing to avoid the many overlaps of authority and responsibility now existing would significantly reduce the total number or poeple required for the reorganized NAVMAT and would, more importantly, lead to the selection of better combat systems.

SECTION 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

Some ship system technical problems cannot be completely solved prior to the introduction of the ship into the Fleet, due to the interjection of new subsystems not adequately integrated into platform operations; however, this problem could be alleviated if combat systems were designed (and tested) as viable entities, rather than separate equipments developed and procured by independent System Commands. In areas where problems have frequently been identified, such as subsystem interfaces and topside integration, early concept freezes to reduce the cycle of iterations and promulgating a set of procedures for a firmer decision-making process would help to minimize the problems.

Increased functions and operation options on modern ships, along with decreased reaction times for AAW, have resulted in a complexity that requires trade-offs in design of subsystems and also establishment of priorities across the total ship; not just at the subsystem level.

Our present organization places the Navy under an extraordinary handicap--overlapping and split responsibilities; extensive delays in passing papers--"coordinating"; getting "chops"; duplicating activities; watered-down professional expertise; non-responsiveness to directives, etc. We urgently need to streamline and reduce people in the chain.

The approach outlined in section 4 could, if implemented, lead to the development of an improved methodology (tool) for the selection of the optimum combat system for US Navy surface ships. The organization proposed in section 4 would eliminate many of the current Navy problems in

combat selection, and would greatly facilitate the methodology proposed in section 4.

6.2. Recommendations

Most of the surface Navy combat system problems are a result of an improper organization; therefore, my first and strongest recommendation is that the Naval Material Command reorganize in accordance with the structure presented in section 5.

Secondly, I recommend that the methodology (tool) proposed in section 4 be made a viable program, probably under 6.3 funds. This program should be integrated with the methodology developed for Naval architects designing hull and propulsion subsystems; thus, eventually a total ship design methodology. Blue sky? I think not. We now have CASDAC (Computer Aided Ship Design and Construction), PF Electromagnetic Effectiveness Determination, ENEWS (Effectiveness of Naval Electronic Warfare Systems), ASMD Candidate Systems Analytical Assessment, Digital Simulation of System Design (submarine control simulation), etc. Most of these were thought to be "blue sky" at some time in the past. They now have proven to be valuable tools.

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APPENDIX 1

ABBREVIATIONS

AAW	Anti Air Warfare
ACS	Air Capable Ship
AEGIS	Advanced Surface Missile System
AGC	Amphibious Flagship
CEB	CNO's Executive Board
CNA	Center for Naval Analysis
CNO	Chief of Naval Operations
DDD	Design Data Document
EMC	Electromagnetic Compatibility
EW	Electronic Warfare
FCS	Fire Control System
IFF	Identification--Friend or Foe
LAH	Amphibious Assault Ship
LFS	Landing Force Support Ship
MAT	Abbreviated prefix for NAVMAT Codes
MCS	Mine Countermeasures Support Ship
MFCS	Missile Fire Control System
NAVMAT	Naval Material Command
NAVSEC	Naval Ship Engineering Center
NAVSHIPS	Naval Ship Systems Command
NMC	Naval Material Command
OP	Abbreviated prefix for OPNAV Codes

OPNAV	Offices and Staff of the Chief of Naval Operations
PABL	Preliminary Allocated Baseline
PF	Patrol Frigate
PMC	Program Management Course
R&D	Research and Development
SCS	Sea Control Ship
SHAPM	Ship Acquisition Program Manager
SHORTSHOP	An EW Suite Comprised of Various Equipments
TDP	Technical Development Plan
TOR	Tactical Operational Requirement
TSOR	Tentative Specific Operational Requirements

APPENDIX 2

EXPLANATION OF TERMS

1. Combat System. The ships Combat System is the combination of equipment and subsystems, exclusive of hull, propulsion and auxiliary machinery systems, that provides the capability for the ship to carry out its primary and contingent missions.

2. Bottoms-up. Generally referred to as the current approach to ship design whereby the hull, space, and weight parameters are determined first, then the equipments and subsystems are selected based on specific equipment capabilities, rather than operational requirements.

3. Top-down. Generally referred to as the approach whereby the "total ship" is considered in regards to its operational requirements and the topside combat system is designed concurrent with hull and machinery design leading to an effective, well-integrated "total ship."

4. System. An assemblage of hardware, personnel and software intended to perform a mission (objective).